SNAP-TECH-06009-A
18 July 2006
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SNAP Primary Mirror Distortions in One Gravity on Kinematic Mounts

Introduction

Distortions due to gravity of a possible design for a SNAP primary mirror are predicted using finite element analysis (FEA). The mirror design analyzed is a 1990mm outside diameter, open-back Zerodur design, detailed in SNAP-TECH-06008. Effects of bipods and flexures are eliminated by using boundary conditions to represent ideal kinematic mounting. Optical surface distortions are predicted both with gravity parallel to and perpendicular to the mirror axis.

Information on the SNAP mission and science are available at the SNAP home page, http://snap.lbl.gov.

The Model

The finite element model is based on the open-back Zerodur design detailed in the drawing SNAP-TECH-06008. The finite element model is illustrated in Figures 1 and 2. It is comprised mainly of plate elements, except in the mounting region, which contains brick elements. The total mass of the finished mirror is 208kg.

Figure 1 shows a side view of the model. This view illustrates the planar-tapered profile of the back of the mirror. From the central opening to a radius of 780mm, the back is flat. From 780mm radius outward, the back is tapered so the depth of the mirror at the outer diameter is approximately 130mm. The mirror depth is approximately 200mm at its deepest, at the corner between the flat and tapered zones.

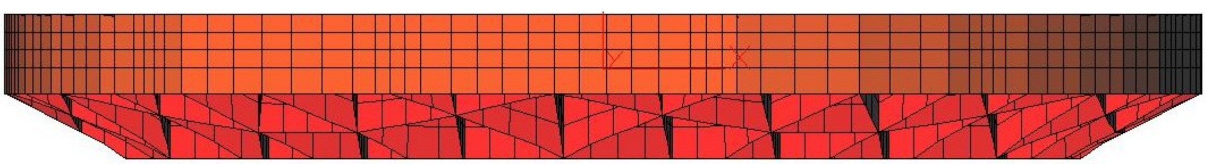

Figure 1-Side view of primary mirror model

Figure 2 shows the back side of the model. The spherical front face sheet in green is 8mm thick. The outer periphery in brown is 8mm thick. The ribs in red are 6mm thick, in a triangular isogrid pattern with each leg of each triangle 195mm long. The reinforced mounting areas in blue are brick elements that extend from the front face to a plane recessed 150mm from the planar back of the mirror, within six of the triangular cells near two-thirds of the mirror outside diameter.

The mirror is supported at three points shown as red donuts, spaced 120 degrees apart. The support points are represented by boundary conditions, each of which allows freedom of rotation in all directions and allows freedom of translation only along lines radial to the mirror as shown by the double-headed arrows.

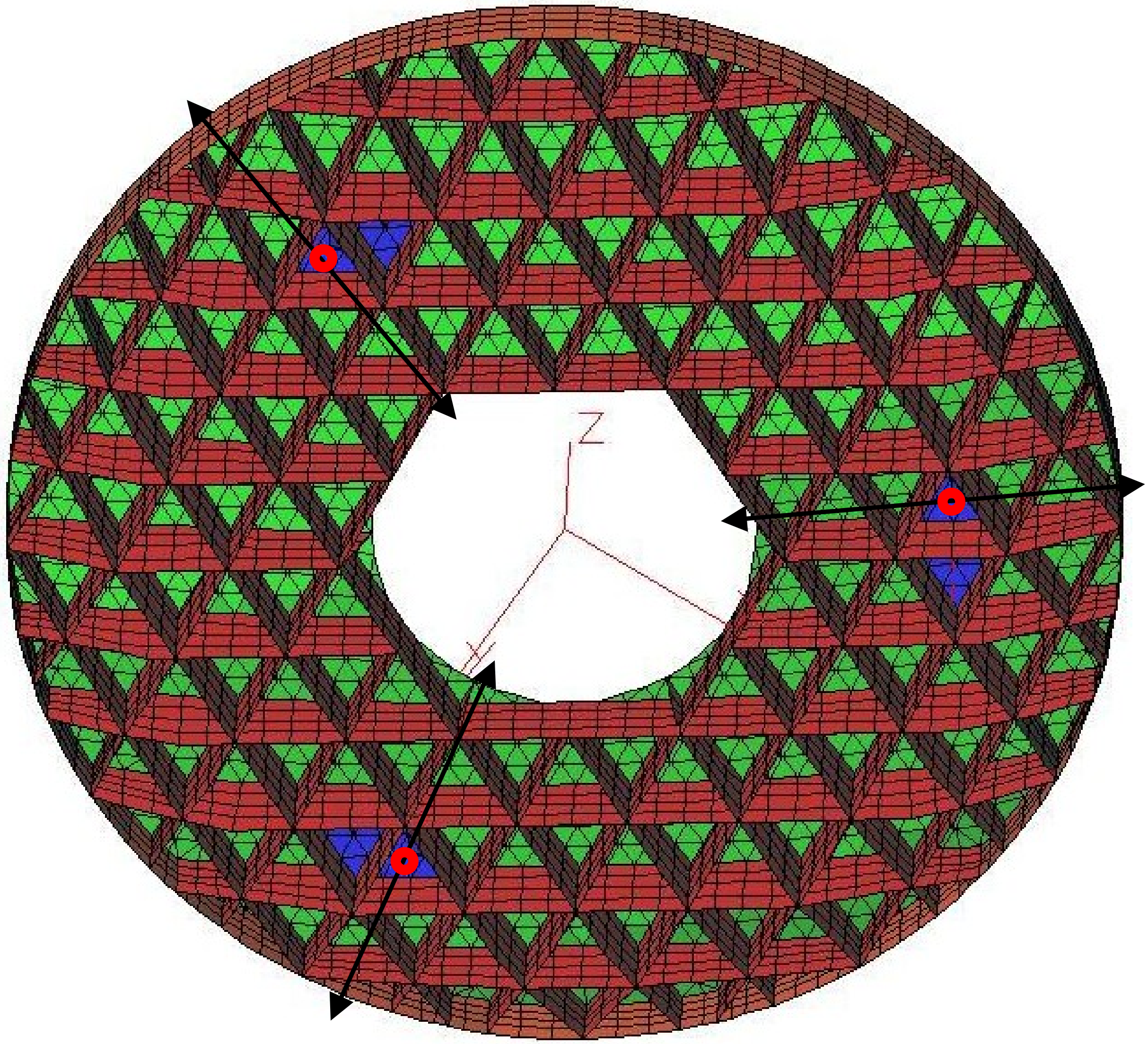

Figure 2-Back side of primary mirror model

Optimizing mount axial positions

The axial positions of the support points (that is, their depth from the back planar surface) are varied to minimize optical surface distortions with the mirror axis oriented horizontally. Figure 3 shows how optical surface distortions (corrected for tilts and piston) vary with axial position of the support points for the horizontal beam configuration subject to one gravity.

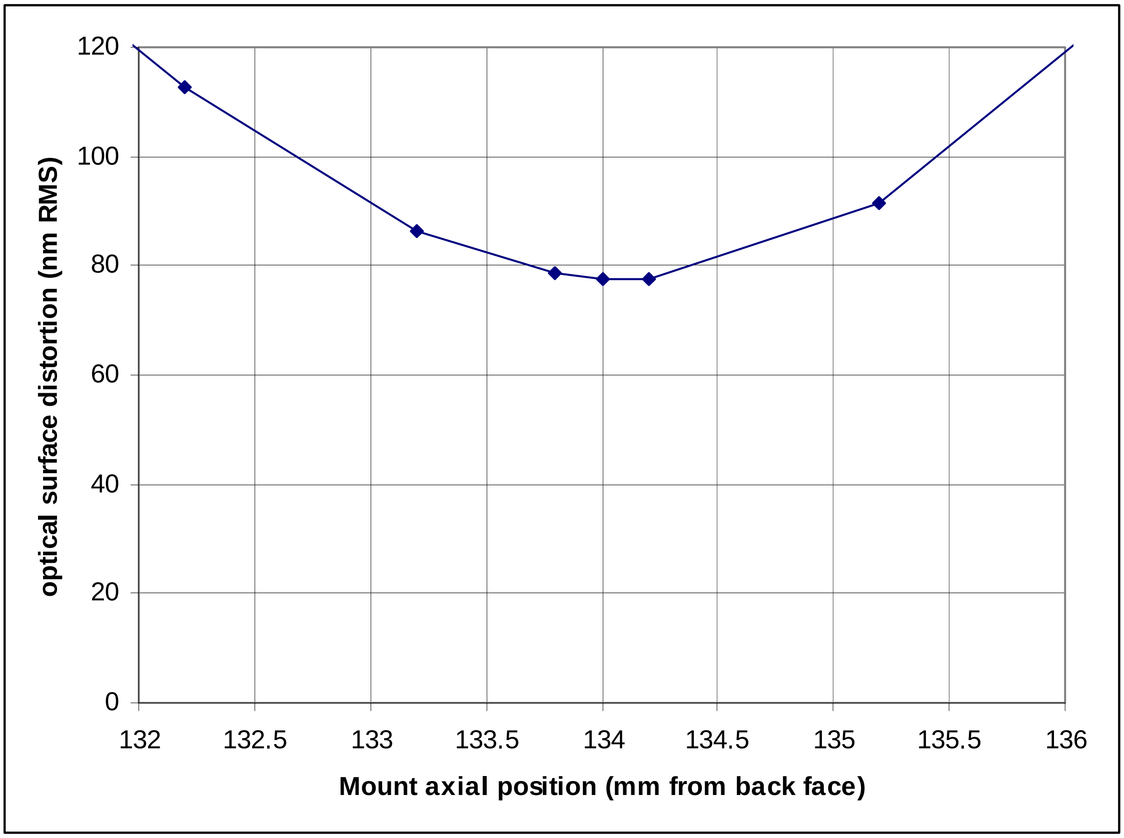

Figure 3-Mirror surface distortions versus mount axial position

Surface distortions in one gravity

Figures 4 and 5 illustrate mirror surface distortions (in meters) parallel to the mirror axis for optimally positioned mounts (134mm deep from the planar back), under one gravity. Figure 4 shows the mirror in the horizontal beam configuration, and Figure 5 shows the vertical beam configuration.

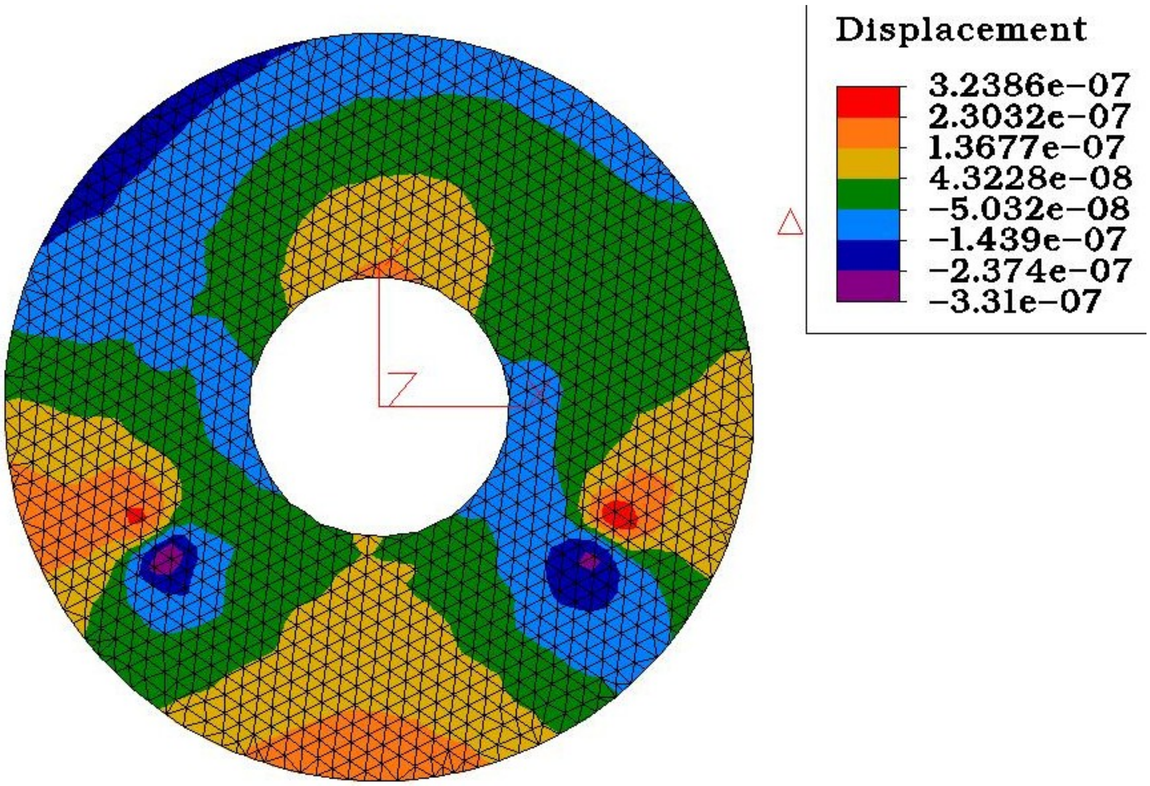

Figure 4-Surface distortions, in meters, in one-g in horizontal beam orientation (78nm RMS, 560nm P-P, corrected for tilts and piston)

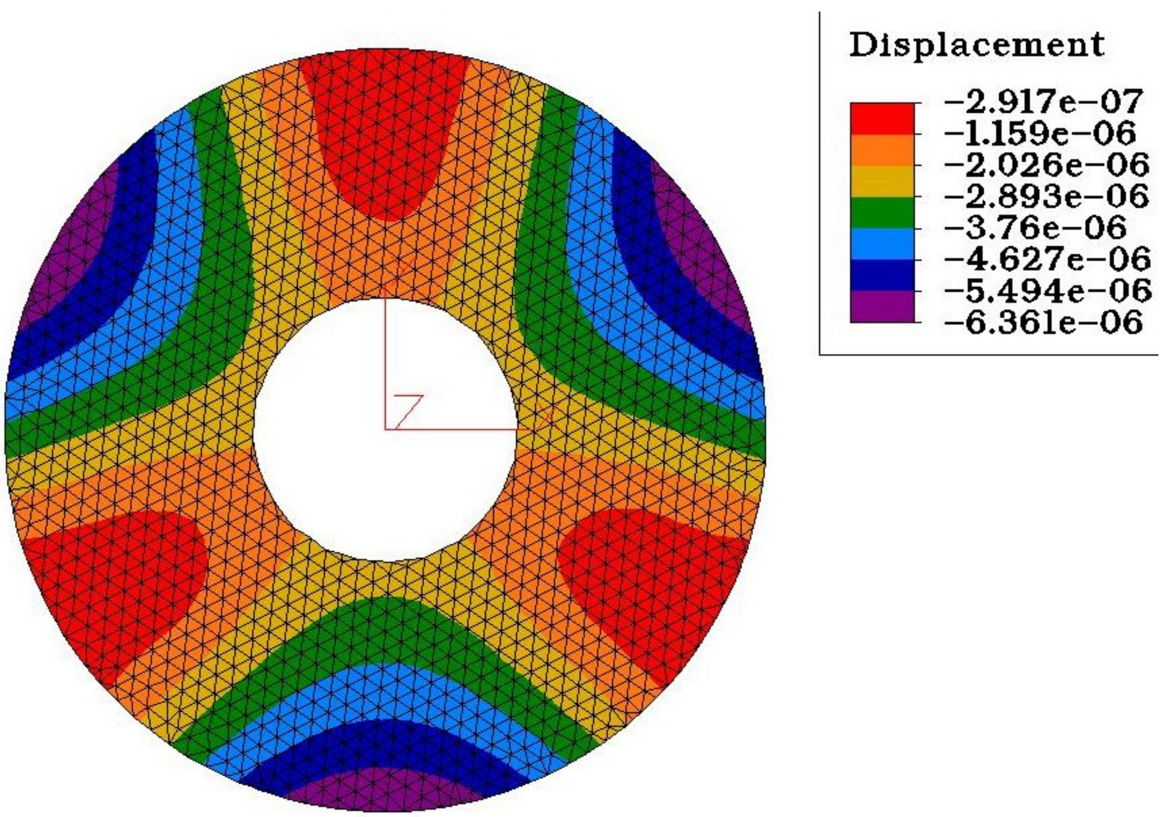

Figure 5-Surface distortions, in meters, in one-g in vertical beam orientation (1.5µm RMS, 6.1µm P-P, corrected for piston)